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Marine Casualty Investigations

Enquêtes sur les accidents maritimes

Investigation Report to the Minister pursuant to sections 542 or 545 of the Canada Shipping Act

Rapport d'investigation au Ministre conformément aux articles 542 ou 545 de la Loi sur la marine marchande du Canada

Canada

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Ce rapport est aussi disponible en français.

INVESTIGATION REPORT INTO THE CIRCUMSTANCES ATTENDING THE STRIKING OF THE CITY DOCK AT THE FOOT OF YONGE STREET, TORONTO, BY THE CANADIAN PASSENGER FERRY "TRILLIUM" RESULTING IN INJURIES TO PASSENGERS, JULY 6, 1986.

REPORT No. 457

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INVESTIGATION REPORT INTO THE CIRCUMSTANCES ATTENDING THE STRIKING OF THE CITY DOCK AT THE FOOT OF YONGE STREET, TORONTO, BY THE CANADIAN PASSENGER FERRY "TRILLIUM", RESULTING IN INJURIES TO PASSENGERS, JULY 6, 1986

Particulars of Vessel

Name	"TRILLIUM"
Official Number	126833
Port of Registry	Toronto
Call Sign	VA4178
Gross Tonnage	611.36
Net Tonnage	425.48
Length	45.72 m
Breadth	9.14 m
Depth	2.21 m
Draught	F: 1.68 m A: 1.68 m
Type	Double ended passenger ferry
Built	1910, Toronto
Re-built	1975, Port Colborne
Propulsion	One, two cylinder, double acting, compound, directly reversing, inclined steam engine designed to develop 48 n.h.p., driving two paddle-wheels connected to one crankshaft, fixed to rotate both paddle-wheels in the same direction. The engines are controlled from an engine-room platform with orders directed from the wheel-house on a bridge/ engine-room telegraph.
Bow thruster	Two, White Gill bow thrusters, one at each end, able to rotate 360°

Crew	7
Passengers	226
Owner	Municipality of Metro Toronto Metro Parks and Property Toronto, Ontario

Navigating Equipment

Radar 1	Kelvin Hughes 0.2-10 nm
Radar 2	Kelvin Hughes 0.2-10 nm
VHF 1	King 7000 Multichannel
VHF 2	King 7000 Multichannel
Magnetic Compass 1	Danforth Constellation
Magnetic Compass 2	Danforth Constellation

Description of Vessel

This is a double-ended, steam-driven, paddle-wheel passenger vessel built in Toronto in 1910 and employed for many years as a Toronto harbour ferry. She was laid up in 1955 and remained out of service until 1975 when, following rebuilding and boiler replacement, she re-entered service as a supplementary ferry and charter cruise vessel.

Initially, the vessel berthed alongside pier 268 at the Yonge Street slip but, as a result of a casualty in 1981, a ferry landing enclosure was constructed in the same area which provided an end-on berth for the vessel.

The "TRILLIUM" has a 'historic' horizontal reciprocating steam engine which is visible on the main deck as is the engineer on the control platform; because of the age of the vessel, this is part of her interest to the travelling public. As the vessel operates on a seasonal basis only, the hours of engine work are limited and are between 300-400 per year.

Bow thrusters were fitted to the vessel in the spring of 1984 prior to the season opening in mid-May. These have the ability to rotate 360° on their own axes and can therefore be used to supplement either ahead or astern propulsion.

The vessel held a valid Steamship Inspection Certificate, SIC 16, limiting the number of passengers to a maximum of 900 when on the ferry crossing and to a maximum of 500 when cruising Toronto outer Harbour but confined to fine, clear weather from May through September.

Note: 1. All times in this report are expressed in Eastern Daylight Saving Time (UTC minus 4 hours).

2. A Glossary of abbreviations and terms can be found following the Findings in this report.

Background

The Canadian passenger ferry "TRILLIUM" was supplementing the Toronto City to Toronto Islands ferry system, on Sunday, July 6, 1986.

After completing one round trip, the vessel was returning to the city dock at the end of her second trip at approximately 1505.

Following a normal approach to the berth, astern propulsion could not be applied to the main engines and the vessel continued her forward momentum, heavily striking the fenders of the west wall of the slip.

Many passengers lost their footing upon impact and some sustained minor injuries. With a large number of passengers aboard, including young and aged of different physical abilities, some standing and many in full stairwells, there was the potential for a much more serious outcome to this casualty.

In 1981, a similar failure to reverse the engine on docking took place. On this occasion the "TRILLIUM" struck and damaged a vessel used as a restaurant. The restaurant vessel subsequently sank and the casualty involved considerable litigation.

Damage to the vessel on this latest occasion was limited to a dent in the port forward bulwark plating and abrasions to the rubbing bumper with an estimated repair cost of $16,000.

There was no pollution as a result of this incident which occurred in approximate position 43°38.4'N, 79°22.5'W.

Reportedly 3 passengers sustained injury which necessitated treatment.

Particulars of Injured Persons

Name	Margaret Sillifant
Position on board	Passenger
Age	73
Address	Stratford, Ontario
Name	Ingrid Russell
Position on board	Passenger
Age	47
Address	Stratford, Ontario
Name	Patricia Clelland
Position on board	Passenger
Age	55
Address	Stratford, Ontario

Narrative

The "TRILLIUM" left the city dock at 1422, July 6, 1986 bound for Centre Island. On board were 900 passengers and a crew of seven. Upon completion of that uneventful crossing, the passengers disembarked and 226 passengers embarked at Centre Island. The vessel then departed from there at 1451 for Toronto.

An apparent normal approach was made to the regular berth at city dock in Toronto with successive reductions in forward speed and eventually the engine was stopped. At this time, there was a south-west wind of 10 knots and a rippled sea but the weather conditions were not considered to be a contributing factor to this incident.

Then an order for slow astern was given from the bridge and, when the master realized that this order had not been executed, he ordered full astern followed by 'double ring' full astern. At the same time, full thrust astern was applied to both bow and stern thrusters, followed by thrust on the bow thruster to move the bow to port in order to avoid

a head-on striking. The vessel subsequently heavily struck the rubber fenders of the dock with the port forward bulwarks.

It transpired that, when the order to stop engine was given, the engineer answered the order on the telegraph and, after bringing the throttle control to zero, he attempted to neutralize the engine by pulling back on the reversing lever. He was still trying to disengage the ahead links when the orders for slow astern and full astern were given. Upon impact, the reversing gear freed itself and astern propulsion was achieved. The majority of the passengers had assembled at the forward gate barrier on the main deck and the stairwell leading down to it. When the vessel made heavy contact, many passengers lost their footing and fell on those in front of them. Some of the less agile passengers sustained minor injuries.

With the engines now going full astern, the vessel had left the slip so a second approach was made with the orders stop, slow ahead, stop, slow astern and stop being given and carried out without difficulty.

The vessel was secured at the dock and of the injured, three required treatment for which they were removed to the hospital by ambulance. The vessel remained alongside until the completion of investigations, repairs, adjustments and trials. Service was resumed at 1400, July 10, 1986, following trials to the satisfaction of a Marine Surveyor from the Ship Safety Branch of the Canadian Coast Guard.

Analysis

1. Mechanical

The engine controls aboard the "TRILLIUM" consist of 5 levers which are operated from the engine platform. Numbered from port to starboard these are:

1 - Low pressure cylinder drain
2 - Reversing lever (ahead and astern links)
3 - Impulse
4 - Throttle valve
5 - High pressure cylinder drain

The control system is historic, although items have been replaced over the years. Originally, there had been a 6th lever which was a control for the main engine pumps but this was removed, following the 1981 casualty, at the request of a Marine Surveyor of the CCG, to

simplify manoeuvring.

The lever controlling the ahead and astern links actuates a rotary valve which introduces steam into the appropriate end of the reversing cylinder, through a linkage having nine bearing pins. A piston in this cylinder moves horizontally to bring the Stephenson's links into the proper configuration for steam to enter the high pressure cylinder thereby turning the paddle-wheels ahead or astern as required. Whilst the vessel is on passage, the piston in the reversing cylinder does not move.

Similar incidents occurred in 1979 and 1981 and both were attributed to the failure of the reversing lever.

In May 1981, a crack was discovered in the reversing cylinder casting and a replacement unit was made. The 1981 casualty occurred one month later.

During the 1985/86 winter layover period, the reversing gear and the manoeuvring valve were due for quadrennial survey. Repairs which were completed to the satisfaction of the CCG SSB included,

(a) reversing engine - skim piston rod and re-sleeve neck bush and gland, and

(b) throttle valve - re-cut keyways in main spindle and actuating lever and supply new key.

At the same time, leads were taken to verify end clearance within the semi-rotary pilot valve to ensure the end cover would not cause seizure under tightening and compression of the gasket material.

In the spring of 1986, several requirements had to be met prior to the issuance of the SIC 16, including a test of the engine manoeuvring. The annual inspection was carried out on May 22 and 23 but on those particular days, the boiler was being serviced by the manufacturer's representatives. An SIC 16 certificate dated May 23 was issued subject to certain deficiencies being rectified. These deficiencies were rectified to the satisfaction of the CCG SSB and on May 29, trials were conducted which included a complete check out of the manoeuvring gear.

2. Faults Found and Corrective Measures Taken

Immediately following the incident and whilst the vessel

was moored at the berth, the chief engineer tried unsuccessfully to simulate the failure.

The day following the incident, a CCG officer of SSB checked the reversing mechanism and, starting with a completely cold engine, carried out a warming up process and found the mechanism operated satisfactorily. He did discover that both the reversing lever and the throttle valves were stiff but both were functioning satisfactorily.

The stiffness of the reversing lever was noted to emanate from axial misalignment of the lever attached to the pilot valve spindle which was bending the hunting link sideways thereby causing heavy wear patterns in the slide and trunnion block of the link. This was adjusted and the operation of the pilot valve and reversing lever became smooth throughout its travel.

It was also noted that the hunting link did not fully centralise in the off position and this resulted in unbalanced angular displacement of the pilot valve relative to shift of the manoeuvring lever, with a bias to the ahead position.

The bottle-screw adjustment in the control link was inadequate to achieve the correct positioning and this link was modified by increasing its length by about 125 mm (5"). In addition, the vertical link from the manoeuvring lever to the pilot valve bell crank was cut, threaded and an adjusting turn-buckle inserted. The gear was then set up and the adjustments locked and further tests were carried out satisfactorily.

The throttle valve remains stiff, although the removal of shims within the valve would ease the operating effect. This would lead to steam leakage through the valve and permit the main engine to creep ahead or astern unless the Stephenson's linkage were to be placed in the neutral position by the reversing engine.

It was suggested that the throttle valve be freed up a little and, to ensure full and complete steam shut off, a stop valve be inserted in the live steam line before the throttle valve, with controls accessible from the manoeuvring platform by means of re-installation of the 6th lever following the incident. Apparently the owners have agreed to these suggestions and the matter is in hand at the time of this investigation.

To support the need for the extra shut-off system, it

was noted that although the throttle valve is unique and original to the vessel and is in excellent condition following a recent rebuild, as is typical of such a valve it is never 100% steam tight.

Since this casualty, the vessel continues to operate without difficulties and the SIC 16 remains in effect.

It was reported that when the vessel was on ferry runs of short duration, the reversing engine was not tested prior to berthing as it was when the vessel was on cruises. The reason given was that it was not normal to do so on ferry voyages because with the trip being so short, the reversing gear does not have a chance to cool down between transits. Directives by the CCG SSB were given to issue standing orders to the operating engineers to always test the reversing engine prior to berthing, irrespective of the status of the voyage.

3. Manoeuvrability

The "TRILLIUM" is propelled by two 4.5 m (15 ft) paddle-wheels, each with 8 self-feathering wooden floats connected to 1 crankshaft, but unusual for a paddle-wheel vessel these are fixed such that both always rotate in the same direction.

As the paddle-wheels are on the sides of the vessel, there is no propeller wash to assist steerage, and she has been described as being difficult to manoeuvre. To somewhat ease this difficulty, bow thrusters were fitted in 1984.

There were indications that on occasion the "TRILLIUM" and other Toronto Islands ferries have made their approaches to the dock at speeds which allowed very little margin for error.

4. Approaching the Berth

The master and mate remain on the bridge during the approximate 15 minute transit and the engineer is constantly on the control platform in the engine-room with an oiler in the vicinity to assist.

During the transit, the three deck-hands are patrolling the deck areas but on arrival, two are stationed at the 'arrival' end of the vessel with the third at the opposite end. There is no direct view of the extremities of the vessel from the wheel-house and communication between deck and wheel-house is maintained by

hand-set radio.

When the vessel is 2 cables from the dock, speed is reduced from a full speed of approximately 8 knots to half speed of approximately 5½ knots. Established points of reference are used for the positions of speed reductions. At 1 cable, the speed is further reduced to slow ahead of approximately 3½ knots and at 3 ship lengths from the dock (135 m), the engines are stopped. Slow astern is usually applied just before the vessel enters the slip. Under normal conditions, these engine movements reportedly stop the vessel adjacent to the slip walls.

On the day of the incident, a normal approach had been made to the point of stop engines. Slow astern was ordered but it was evident that the vessel was not slowing down and the master believed the paddle-wheels were still rotating ahead. Being an existing vessel under 1600 tons, the "TRILLIUM" was not required by the Navigating Appliances and Equipment Regulations to be fitted with a tachometer in the wheel-house for revolution reference. The order for full astern was given but apparently was not answered from the control platform so a 'double ring' full astern was ordered, again without response. The master had previously pre-positioned the bow thrusters for astern propulsion, as was his regular practice, so these were activated to maximum.

The response was insufficient to stop the vessel but certainly prevented a heavier impact and more serious damage. Just prior to impact, the forward thruster was angled to move the bow to port so that impact would be on the rubber fenders of the slip wall rather than the concrete 'slot'.

On the engine control platform, the chief engineer executed the manoeuvres as far as the stop order. At this point, he brought the throttle lever to the stop position and tried to disengage the ahead links with the reversing lever. As there was a slight steam leakage, the paddle-wheels were still turning ahead at an estimated 8 or 9 r.p.m. Several efforts were made to move the reversing lever but without success. The engineer can monitor the progress of the vessel from the control platform so, when he realized he could not move the reversing lever and that the vessel was still being propelled ahead, he shouted to the oiler to shut off the steam supply to the engine. This action was too late as the vessel made impact soon after and the reversing lever 'bounced out' of its jammed position. So the

engineer countermanded his order to the oiler and, following engine orders from the wheel-house, manoeuvred the controls without any further problem as the vessel docked and secured.

5. Passenger Control

There are cautionary signs on the port and starboard bulkheads of the upper passenger deck which state:

IN THE INTEREST OF PUBLIC SAFETY
ALL PASSENGERS SHOULD REMAIN
SEATED UNTIL VESSEL HAS
DOCKED

Apparently, there were similar signs displayed at the fore and aft stairwells but these were replaced in 1985 with celebratory information during the 75th anniversary of the vessel; the cautionary signs were never returned to their original positions.

Although the vessel is licensed to carry 900 passengers when on the ferry run, there is seating for only approximately 500. There is no provision contained in the Canada Shipping Act which governs the seating capacity of a passenger ferry with relation to the number of persons the vessel is licensed to carry.

The vessel is equipped with a multi-station communications system with the 'master control' in the wheel-house and speakers at the fore and aft mooring stations and on the engine control platform. In addition, there is a public address system with the 'master control' on the main deck and a remote microphone in the wheel-house. Speakers are positioned throughout the passenger areas and, during this investigation, tests indicated that any broadcast from either control station should be audible in any part of the passenger deck spaces.

Apparently no broadcasts were made to draw the passenger's attention to the posted notices.

At each end of the main deck, there is a steel-barred fence across the width of the vessel with entry beyond gained through a hinged steel-barred double gate.

During transit, these gates are reportedly closed and secured as a safety measure to prevent passengers from wandering to the extremities of the vessel where there is open access to the water. The gates remain closed

until the vessel is secured in her berth.

Leading down to the gates from the second deck are centrally divided stairwells.

As the vessel makes her approach to the berth, it has been the practice of passengers to assemble at the gates and on the stairwell to facilitate a speedy disembarkation. Consequently, even with 200 passengers on board, these areas would be filled with people.

So it was that, on this particular occasion, the area abaft the barrier and that in the stairwells were filled with passengers when the vessel struck the slip wall although reports indicate that approximately 25% of the passengers remained seated. Just prior to impact, one deck-hand apparently shouted a warning to the passengers. Of those standing closest to the fencing, one elderly lady was pushed into the fence and then fell and many others who were behind fell on top of her. She sustained heavy bruising to the breast-bone area. A second lady who was standing at the foot of the stairwell was thrown forward over a wheelchair passenger. She tried to break her own fall with her arms and in so doing, suffered a pinched spinal nerve and pain in the lower lumbar region. A third lady was standing close to the starboard side of the fence checking off a number of clients from the Stratford and District Association for the Mentally Retarded (SDAMR) of which there were 33 on board plus 13 volunteers. She put her right arm up to protect her head as she was pushed into the fence. She sustained heavy bruising to the arm. Many of the clients of SDAMR were apparently shaken up and sustained minor bruising.

There was a registered nurse amongst the passengers who reportedly gave whatever assistance and comfort she could to the injured and who was acclaimed by many. She assisted three passengers into an ambulance, which the master had called, and after discovering that the elderly lady who had been fallen upon had a cardiac history, she ensured that oxygen was administered in the ambulance. None of those taken to hospital were detained after examination and treatment although one was off work for 5 weeks.

6. Vessel Records

Difficulties were faced during the investigation because of the inability to find documentation and records of the vessel. The owner of the vessel, Metro Toronto, is

a vast organization with many departments which, no doubt, partially explains this situation.

7. **Personnel**

The master of the "TRILLIUM" holds a Canadian Certificate of Competency as Master Minor Waters issued in 1972. He has been at sea for 25 years including 10 years on the Metro Parks and Property ferries sailing as master. He had commanded all their ferries except the "TRILLIUM" and the day of the casualty was his first day in command of that vessel. He had familiarised himself with the handling of the vessel during the 2 days preceding the casualty. However this lack of experience of the ferry is not considered to have been a contributing factor.

The mate holds a British Certificate of Competency as Master Foreign Going issued in 1955. He has been at sea for 26 years including 10 years with Metro Parks and Property ferries. He has been on the "TRILLIUM" for 3 years for its seasonal operation.

The chief engineer holds a Canadian Certificate of Competency as Second Class Engineer on a steam-driven ship issued in 1986 and a Certificate of Competency as Third Class Engineer on a motor-driven ship issued in 1979. He has been at sea for 12 years including 4 years as chief engineer. This is his second year on the "TRILLIUM" as chief engineer.

Findings

The "TRILLIUM" struck the dock wall at City Docks, Toronto, because the reversing lever controlling the ahead/-astern links could not be manoeuvred to disengage the ahead links.

The precise cause for the reversing lever to jam could not be established, however, it is possible that the following may have occured:

- axial misalignment of the reversing lever attached to the pilot valve spindle caused stiffness in the linkage, and/or

- the hunting link not being fully centralized in the off position resulted in unbalanced displacement of the pilot valve relative to shift of the manoeuvring lever, with a bias to the ahead

position.

Also contributing to the forward motion of the vessel was a steam leakage of the throttle valve, later rectified, which allowed the paddle-wheels to continue rotating ahead despite the throttle control being brought to zero.

Other Findings

The master's pre-planning and use of the thrusters prevented possibly more serious consequences.

Some of the warning notices advising passengers to remain seated on arrival had been removed.

Most of the passengers on board did not comply with the remaining safety warnings posted on the bulkheads.

No safety warning was broadcast over the P/A system in conjunction with the posted safety warning, prior to the approach of the vessel to the berth.

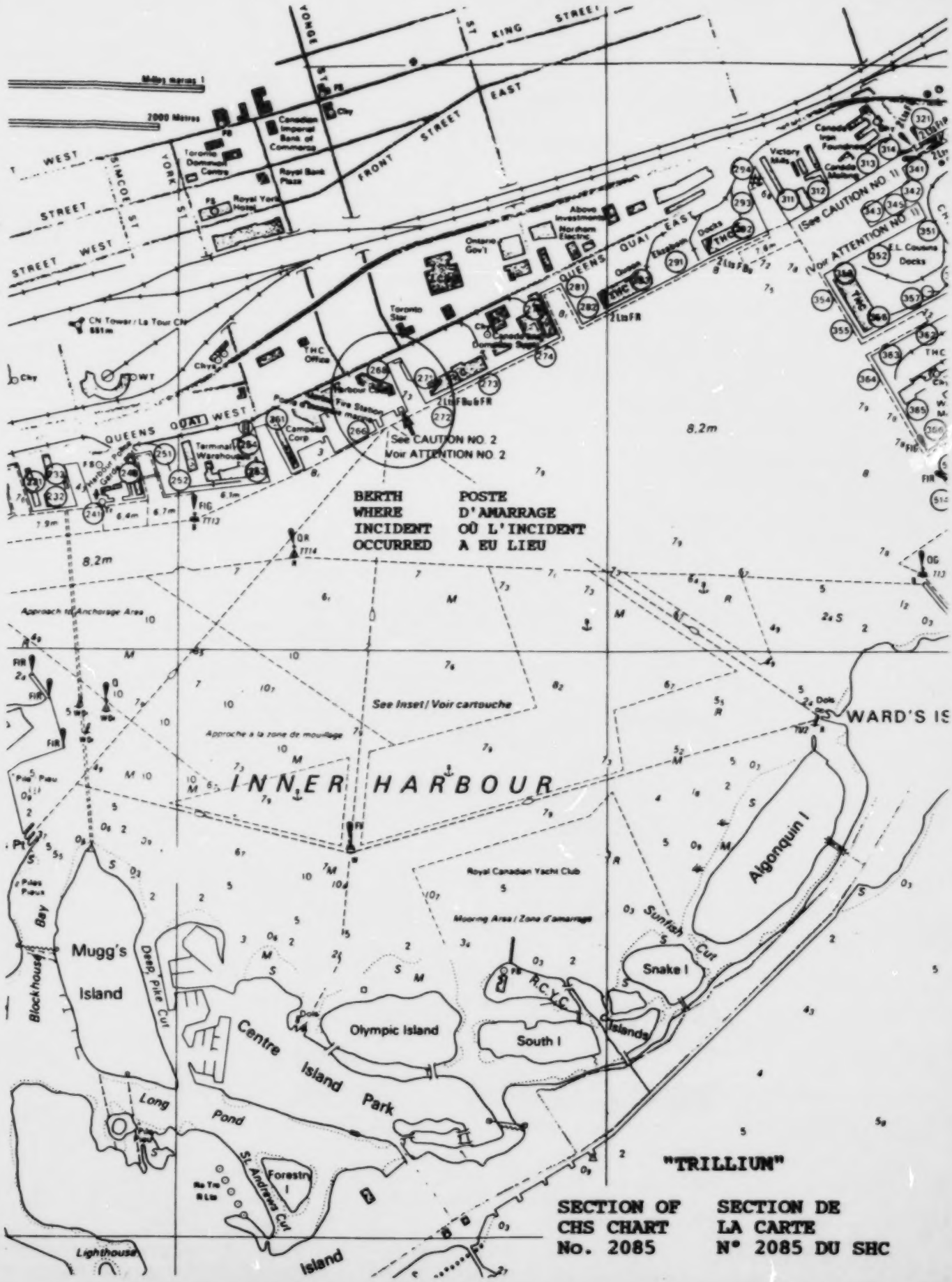
There is insufficient seating for the number of passengers the vessel is licensed to carry.

A registered nurse, who was a passenger aboard, was acclaimed by several passengers for her professional services.

OTTAWA, ONTARIO.
DECEMBER, 1986.

Glossary

bulkhead	A name given to any vertical partition which separates different compartments from one another. i.e. a wall.
bulwark	The upper section of the frames and side plating, which extend around the deck and serve as a fence.
cable	185 m (608 ft)
CCG, SSB	Canadian Coast Guard, Ship Safety Branch
fender	Term applied to various devices, fixed or portable serving to cushion shocks and protect the shell plating when a vessel comes in contact with a dock wall.
lead	The amount a port is open to steam when a piston is at the beginning of its travel.
P/A System	Public Address System


KING STREET
FRONT STREET EAST
QUEENS QUAY WEST
QUEENS QUAI EAST
YONGE ST
YORK ST
SIMCOE ST
WEST STREET
CN Tower / La Tour CN
Toronto Dominion Centre
Canadian Imperial Bank of Commerce
Royal Bank Plaza
Royal York Hotel
Toronto Star
Ontario Govt
Above Investments
Northern Electric
Victory Mills
Canada Malting
Canada Iron Foundries
E.L. Cousins Docks
THC Office
Harbour Office
Fire Station
Terminal Warehouse
Campbell Corp
See CAUTION NO. 2
Voir ATTENTION NO. 2
See CAUTION NO. 11
Voir ATTENTION NO. 11
BERTH WHERE INCIDENT OCCURRED
POSTE D'AMARRAGE OÙ L'INCIDENT A EU LIEU
8.2m
Approach to Anchorage Area
Approche à la zone de mouillage
See Inset / Voir cartouche
INNER HARBOUR
WARD'S IS
Algonquin I
Royal Canadian Yacht Club
Mooring Area / Zone d'amarrage
Sunfish Cut
Snake I
R.C.Y.C.
Islands
Mugg's Island
Blockhouse Bay
Deep Pike Cut
Centre Island Park
Olympic Island
South I
Long Pond
St. Andrews Cut
Forestry I
Lighthouse Island
"TRILLIUN"
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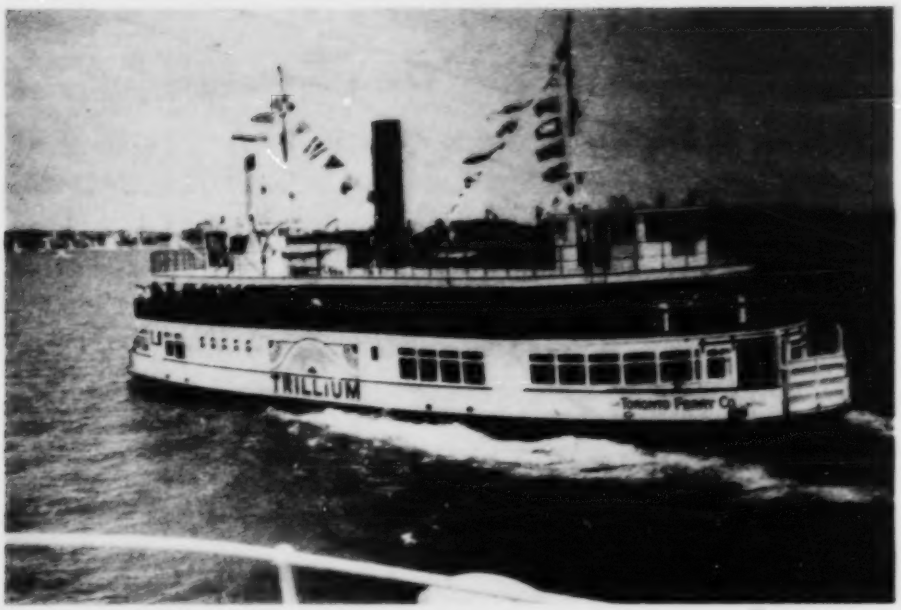
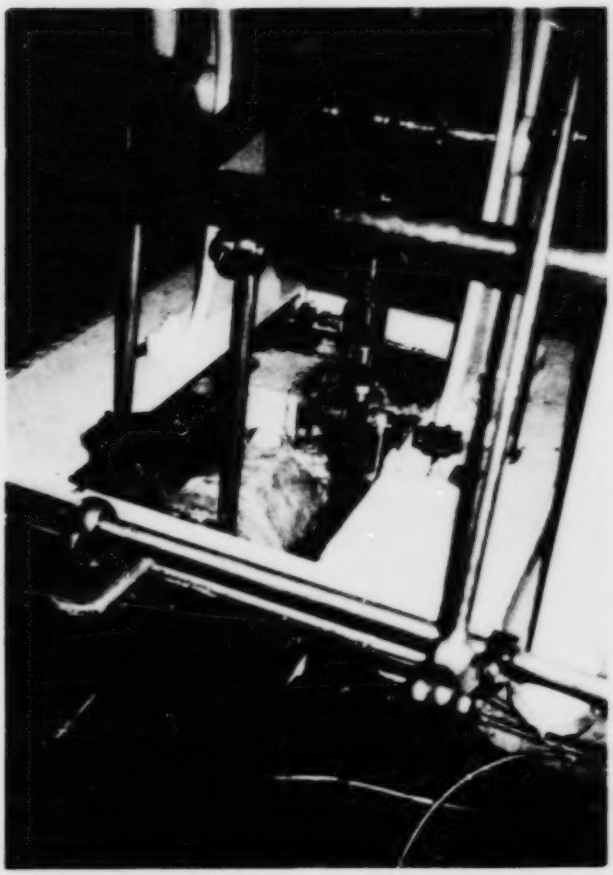
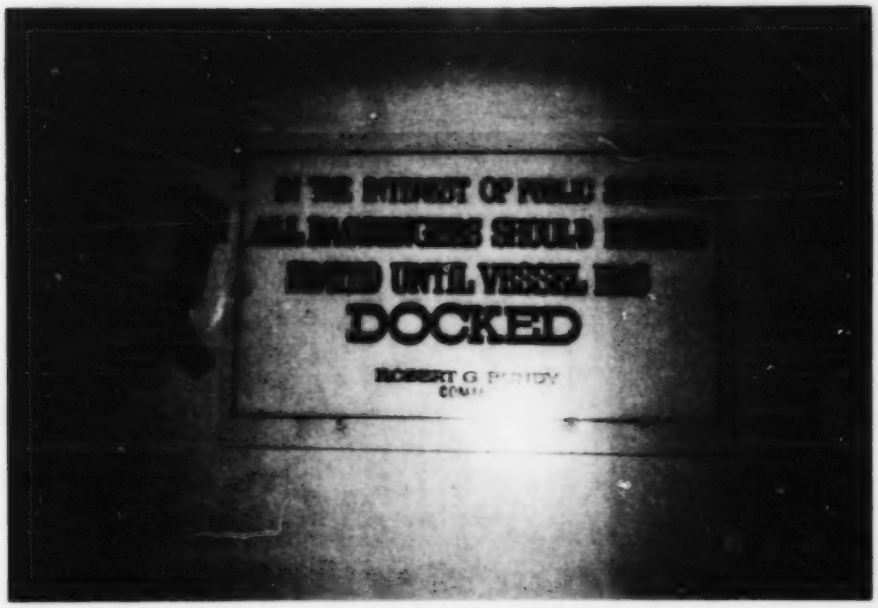


"TRILLIUM"



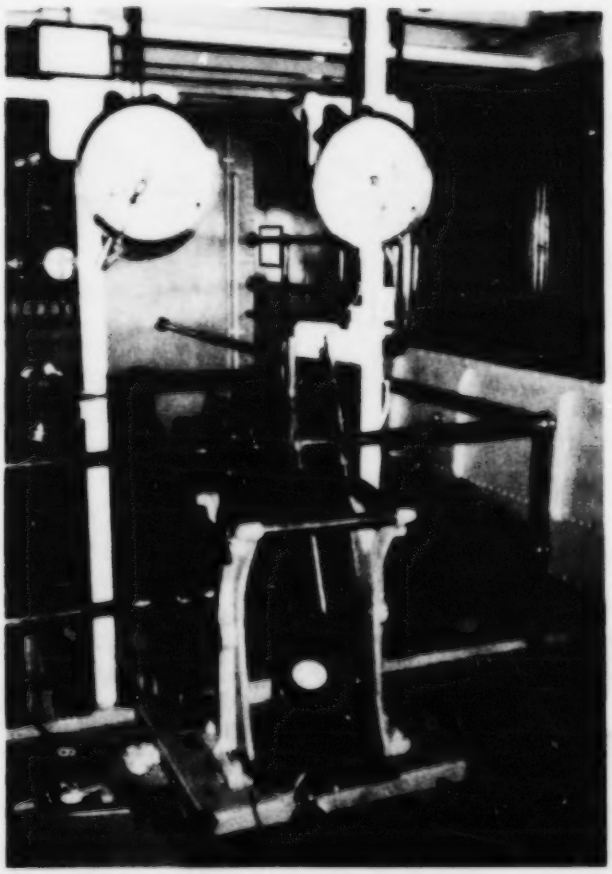
Turnbuckle inserted to extend the reverse driving rod.

Ridoir installé pour rallonger la tige de commande de renversement.



Safety signs posted on port and starboard upper deck.

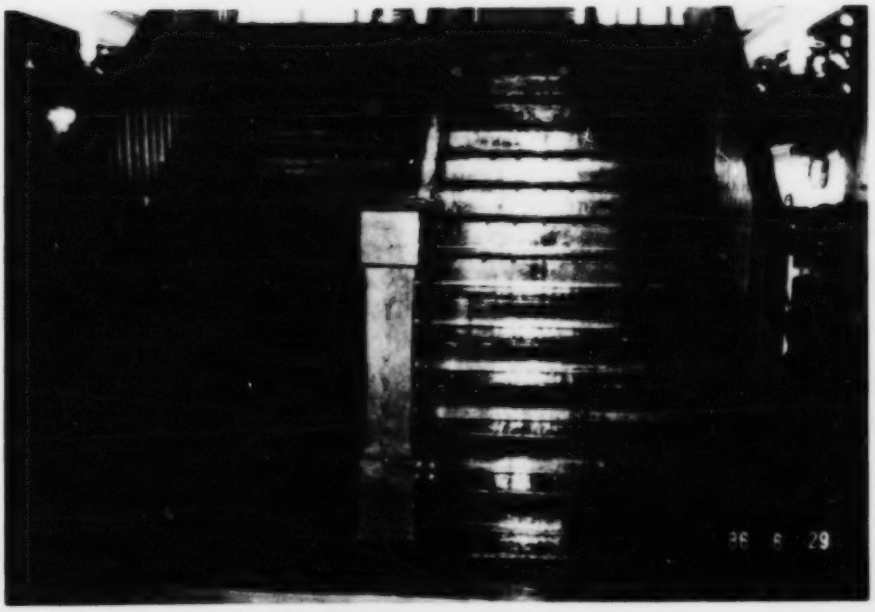
Enseigne de sécurité telle qu'affichée à bâbord et tribord sur le pont supérieur.



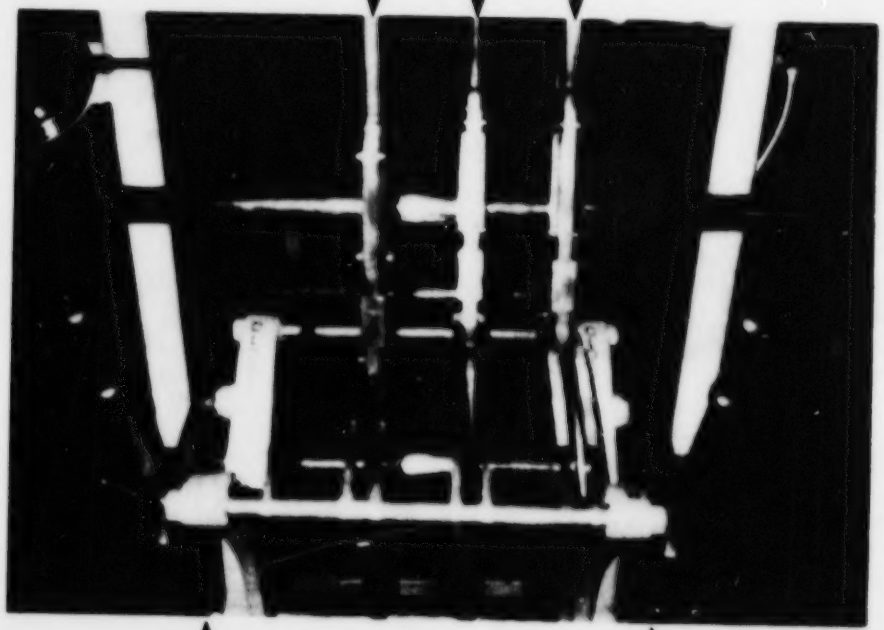
Engine control platform.

Parquet du poste de commande de la machine.

Wrought iron fencing at forward end of vessel.
Clôture en fer forgé à l'avant du navire.



Forward stairwell down to fencing.
Descente avant donnant accès à la clôture.

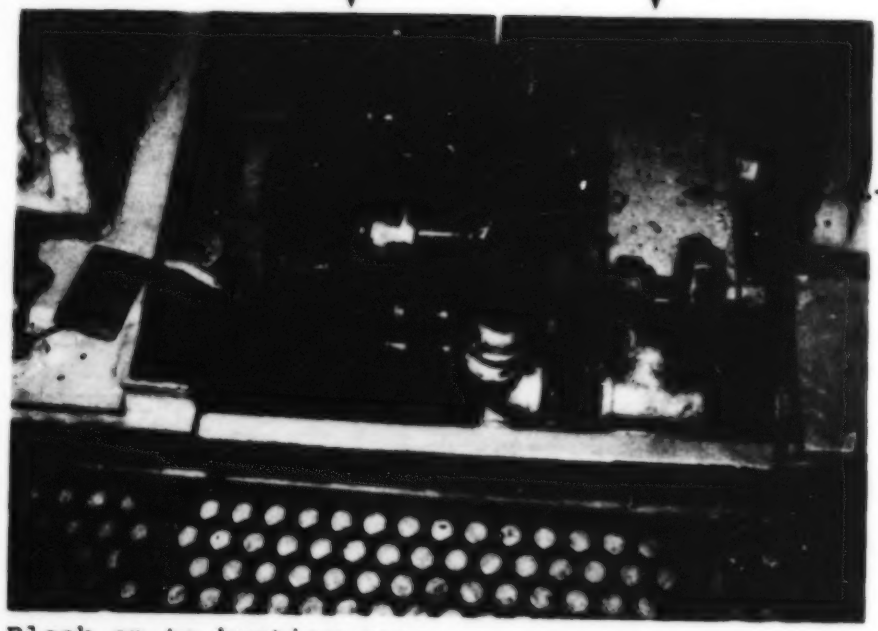


Lever system

Système de levier

Reversing lever
Levier de renversement de marche

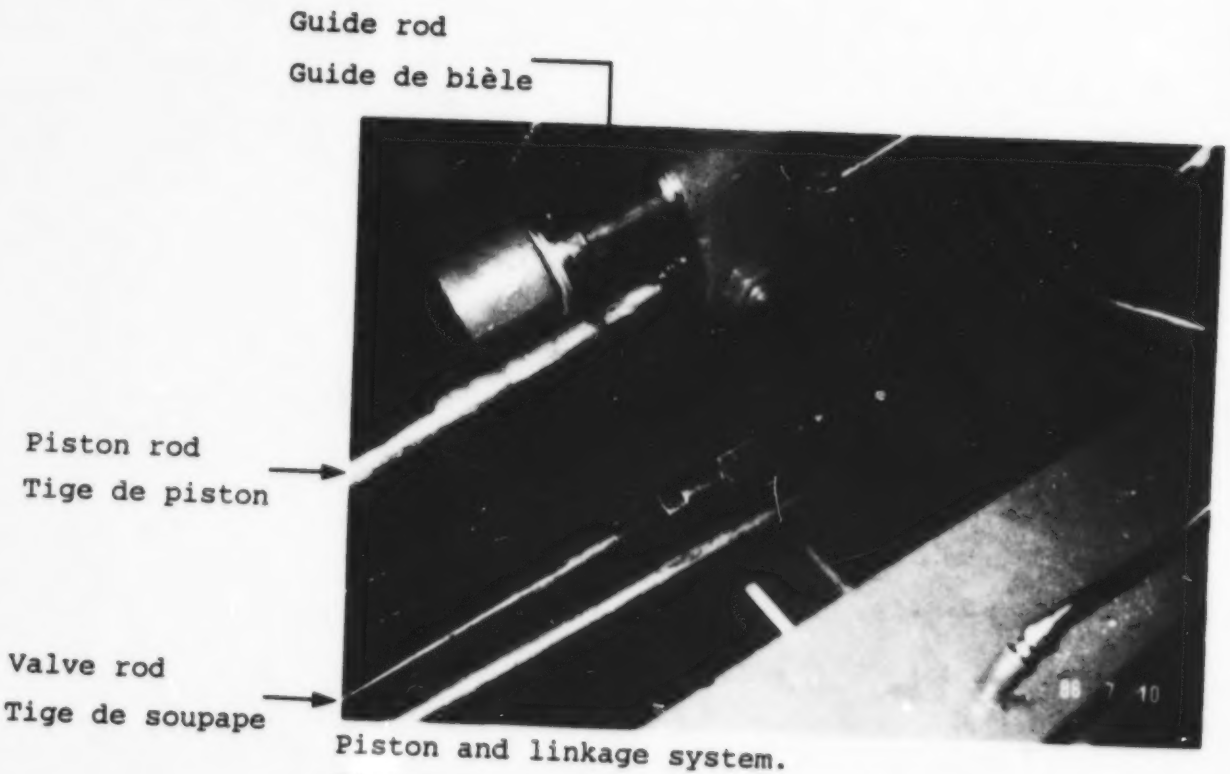
Steam cylinder
Cylindre à vapeur



Block
Bloc

Block on to hunting gear.
Bloc sur le mécanisme de commande.

Piston and linkage system.
Piston et système de tringlerie.



Piston and linkage system.
Piston et système de tringlerie.